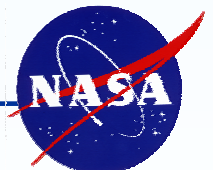# Software Architecture Options for True Telescience

Joseph G. Ponyik

NASA Glenn Research Center

Glenn Research Center

at Lewis Field
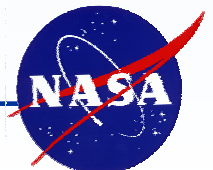
SW Architecture Options for True Telescience

- ## What is "Telescience"?
  - The ability to conduct a science investigation from a remote location in near real-time
  - Example: Operating a science payload on the International Space Station from a central Telescience Support Center (TSC)

- ## What is "True Telescience"?
  - Telescience from one's home or office with minimal or no use of a control center such as a TSC

Glenn Research Center
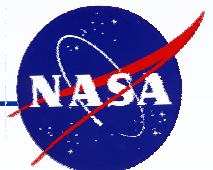
SW Architecture Options for True Telescience

- ## Advantages of True Telescience

  – Control Center operations are simplified, reducing costs

  – Easier for Principal Investigators to interact with their experiment

    - Work from home office rather than traveling to a Control Center

    - Web based operations eliminate the need for the Principal Investigator to utilize custom software
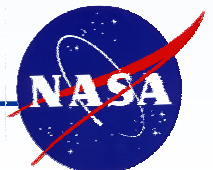
SW Architecture Options for True Telescience

- ## What factors should be considered?
  - Number of users who will be accessing the investigation at any one time
  - Round trip latency time
  - Data sampling rate
  - A combination of these three factors must be considered
  - Example: A sampling rate of 1 Hz with a round trip latency time of about 0.55 seconds and 2 users accessing the remote system will require a proxy
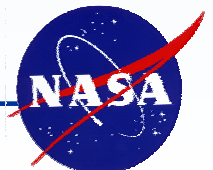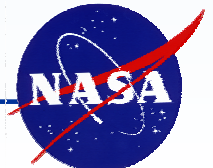
SW Architecture Options for True Telescience

- ## What factors should be considered? (continued)
  - ### Security
    - Needed to keep unauthorized users out of the system
    - Need for the architecture to support commercial security products?
    - Example: Virtual Private Networks (VPNs) provide a secure link between a remote user on the internet and a system "behind" the VPN
    - In the upcoming options, a VPN is utilized with the VPN client software on the users computer installed and communicating with the VPN server
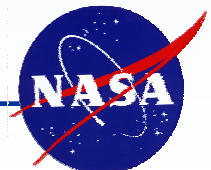
SW Architecture Options for True Telescience

- ## Common features of the architecture options
  - Embedded Web Technology
    - It provides a computerized system the ability to act as a node on the World Wide Web, allowing remote users the ability to do control and monitoring over the World Wide Web with only a web browser
    - Advantages
      - The user can be anywhere on the internet
      - The user only needs a web browser, no special software
  - Virtual Private Network utilized for security
 - TCP/IP used for communication

SW Architecture Options for True Telescience

- **Two Architecture Options to be presented**
  - Option 1: Complex architecture requiring controlled access and many users
    - Experiments onboard the International Space Station
  - Option 2: Simple architecture with limited number of users
    - Communicating with a ground-based experiment over a satellite
  - These options were demonstrated at Inspection 99 and Inspection 2000 at JSC utilizing ACTS and TDRSS satellites to remotely control a typical experiment

SW Architecture Options for True Telescience

- Option 1: Complex architecture requiring controlled access and many users
  - Remote payload is operating onboard the International Space Station along with many others
  - Many users will be accessing their payloads
  - Need to be able to control access to prevent resource overloading and prevent unauthorized use
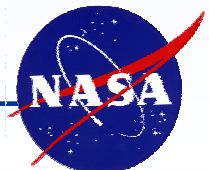
Option 1

Acronyms:
VPN – Virtual Private Network
ISS – International Space Station
TDRSS – Telemetry and Data Relay Satellite System
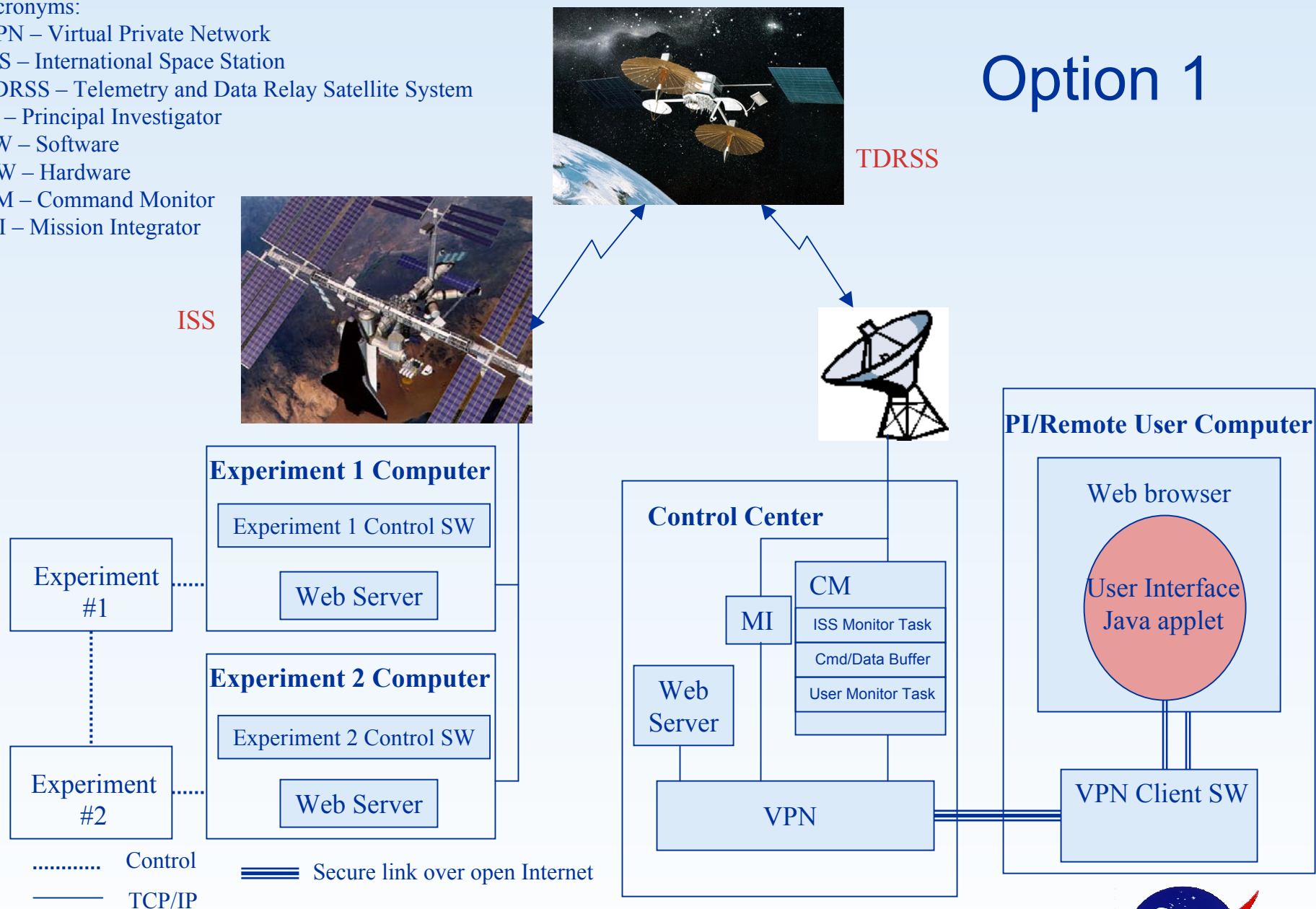PI – Principal Investigator
SW – Software
HW – Hardware
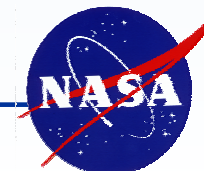CM – Command Monitor
MI – Mission Integrator

TDRSS

ISS

Experiment 1 Computer
- Experiment 1 Control SW
- Web Server

Experiment 2 Computer
- Experiment 2 Control SW
- Web Server

Experiment #1

Experiment #2

Control Center
- MI
- Web Server
- CM
  - ISS Monitor Task
  - Cmd/Data Buffer
  - User Monitor Task
- VPN

PI/Remote User Computer
- Web browser
  - User Interface Java applet
- VPN Client SW

.... Control

———— TCP/IP

═══ Secure link over open Internet

Glenn Research Center

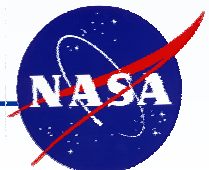Space Internet Workshop #3

at Lewis Field

9

SW Architecture Options for True Telescience

- **Option 1 Description**
  - Command Monitor acts as a proxy between the users and their payloads
    - A proxy provides a communication relay between 2 computers
  - Command Monitor establishes a connection to the onboard experiments
  - Control Center runs a web server to deliver the user interface software to the ground based user
 - Onboard experiment computers also run web servers for crew usage
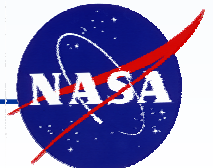
SW Architecture Options for True Telescience

- ## Option 1 Description (continued)
  - Control Center has two applications - Mission Integrator and Command Monitor - used to control access to the onboard experiments
  - In operation, users connect to Control Center's web server which serves up interface
  - Control Center buffers experiment data at a given rate, say 1 Hz, and sends buffered data to the users when they request it
  - Control Center relays commands from the users to the onboard experiments as permitted
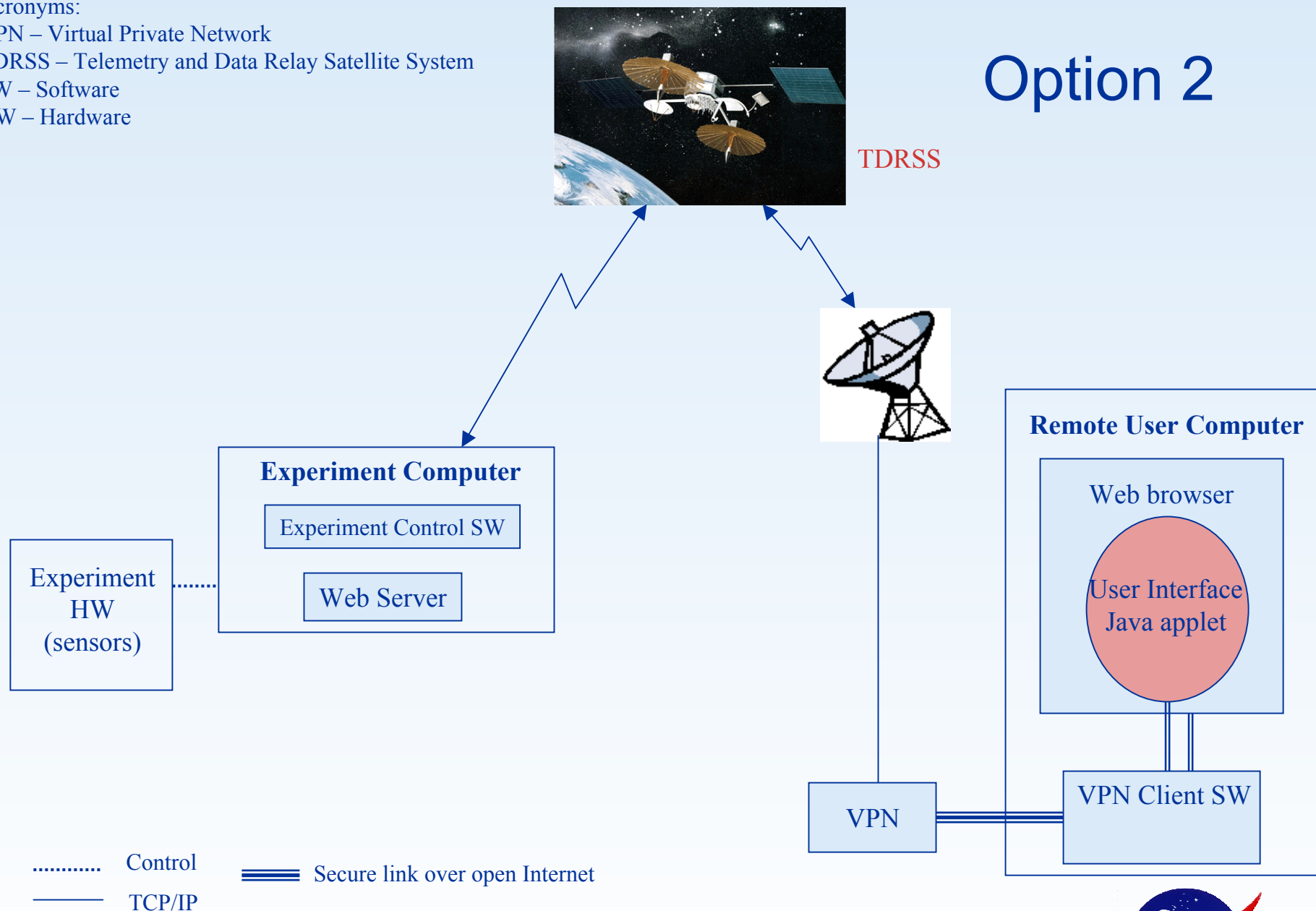
SW Architecture Options for True Telescience

- Option 2: Simple architecture with limited number of users

  - The experiment is located remotely from the investigator

  - Users may be requesting data at a slow rate on demand, not continuous

  - No need to control resources
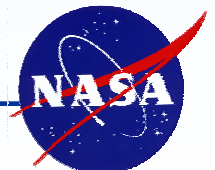
Acronyms:
VPN – Virtual Private Network
TDRSS – Telemetry and Data Relay Satellite System
SW – Software
HW – Hardware

Option 2

TDRSS

Experiment Computer

Experiment Control SW

Web Server

Experiment
HW
(sensors)

Remote User Computer

Web browser

User Interface
Java applet

VPN Client SW

VPN

.... Control

═══ Secure link over open Internet

——— TCP/IP

SW Architecture Options for True Telescience

- ## Option 2 Description
  - No proxy needed between the users and the experiment
  - Experiment computer runs a web server to deliver the user interface software to the user
    - Server could also supply data
  - Satellite simply relays data between the user and the experiment

Glenn Research Center